

REMARKS

The Official Action has been carefully considered and reconsideration and further examination of the application as amended is respectfully requested.

Claims 1 and 13 have been amended to correct errors of a typographical nature. Claim 16 has been amended to remove the basis for the Examiner's objection at paragraph 2 of the Official Action.

Claim 1 has been further amended to remove the basis for the rejection under 35 U.S.C. §112, second paragraph at paragraph 4 of the Official Action, and to make it clear that the claim is directed to a (direct) alcohol fuel cell wherein the alcohol is directly fed to the fuel cell without intervening stages in the process technology. This requires, among other things, that the anode is effective for oxidation of a (liquid) alcohol. Support for the new recitation in the claim appears, for example, in the specification as filed at page 4, lines 21-22.

Claims 1 and 4 stand rejected under 35 U.S.C. §103(a) as allegedly being obvious over Tetzlaff et al. (US 5,656,389) in view of Divisek (WO01/61776, US equivalent document US 7,056,610 relied upon for translation). The dependent claims also stand rejected as allegedly being obvious over the above references in further view of the additional references cited at pages 4-17 of the Official Action. Applicant respectfully traverses these rejections.

As discussed in detail in Applicants' Amendment filed 4 March 2008, the claimed invention is based at least in part on Applicants' discovery that an efficient direct alcohol air fuel cell can employ an alkaline liquid electrolyte whereby to avoid the drawbacks encountered in the direct alcohol air fuel cells of the prior art and to enable the use of a non-platinum catalyst. Based on this discovery, independent claim 1 recites an alcohol-air fuel cell comprising (a) an anode chamber with a liquid catalytically active anode (**wherein the anode is suitable for operation with a liquid fuel**), (b) an air chamber with a catalytically active gas-diffusion cathode, (c) an electrolyte chamber with a liquid electrolyte and a membrane electrolyte. In other words, the membrane electrolyte is recited as a separate constitutional element and is not a constituent of the anode as taught in Tetzlaff (see discussion below).

In contrast, the primary reference, Tetzlaff, discloses an electrochemical cell having a **gas-diffusion** cathode and anode separated by an electrolyte chamber containing a liquid electrolyte, and an ion-exchange membrane that is pressed onto the anode and is thus an integral part of the anode. Both the anode and the cathode are designed for use with gaseous reagents. **The anode is not suitable for operation with a liquid fuel.**

The Examiner has acknowledged that Tetzlaff does not show a direct fuel cell wherein an alcohol fuel is introduced directly in a fuel cell with an anode suitable for operating with this liquid fuel, but she contends that it would have been obvious to use the direct methanol fuel of Divisek in the Tetzlaff fuel cell "in

order to simplify the system". The Examiner is respectfully combining apples with oranges in a hindsight reconstruction of two (2) different types of fuel cells.

As is made clear in the Background portion of the Divisek reference, these are distinct types of fuel cells: (1) the so-called indirect methanol fuel cell in which a hydrogen-rich gas mixture is produced and introduced into a polymer electrolyte fuel cell of the usual hydrogen type with anodic Pu/Ru catalyst and (2) the direct alcohol fuel cell that is the subject of the invention in Divisek (see Divisek at column 1, line 52-column 2, line 6).

Divisek does not teach that a *direct* methanol fuel cell can alternatively use gas fuel or that an *indirect* fuel cell can alternatively use liquid fuel. Rather, he discloses only that *indirect* methanol fuel cells must transform methane or methanol to hydrogen or hydrogen-rich gases in order to fuel the cell (see col. 1, lines 55-66). Neither Applicants' claimed invention nor the disclosure in Tetzlaff apply to *indirect* methanol fuel cells.

In short, there is respectfully nothing in the references that would show or suggest that one may simply replace the hydrogen-rich gaseous mixture of the former (indirect) fuel cell with the liquid alcohol fuel of the latter (direct) fuel cell with a reasonable expectation of success, and the Examiner has respectfully provided no articulated reasoning with rationale underpinning for this contention.

Indeed, since the anode of the former is not suitable for operation with a liquid fuel, the proposed substitution would not work. There accordingly could not be

any motivation, reason or rationale for the proposed modification sufficient to set forth even a *prima facie* case of obviousness for the invention as claimed. See MPEP 2143.01(VI) ("If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious."); see, also, MPEP 2143.01(V) ("If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification.").

Additionally, Tetzlaff discloses an electrochemical cell having the gas-diffusion cathode and anode separated by an electrolyte chamber containing a liquid electrolyte, and an ion-exchange membrane being pressed onto the anode, thus being an integral part of the anode. Both the anode and cathode use the gaseous reagents. On the cathode, as a catalyst silver is used, which metal is a particular case of a non-platinum catalyst, that is tolerant in respect of an alcohol.

Divisek discloses a direct methanol-based fuel cell including, to ensure its serviceability, two fuel cells: a fuel cell having an anion-conductive membrane, and an acid-based fuel cell that delivers water to the cathode of the fuel cell provided with an anion-conductive membrane. This reference teaches nothing about an aqueous solution of alkali to be used as the electrolyte. As discussed above, the methanol-based fuel of Divisek cannot be used in the electrochemical cell of Tetzlaff, for the reason that the gas-diffusion anode is not suitable for

operation with a liquid fuel. Further, Divisek uses a methanol-water mixture.

The membrane electrolyte is a separate structural element of the invention as claimed in Claim 1, not a constituent of the anode as is taught by Tetzlaff, whereby the proposed combination of references is insufficient to set forth even a *prima facie* case of obviousness of claim 1 for this reason as well.

The other cited secondary references cannot supplement the aforementioned deficiencies in the primary reference whereby claim 1 and the claims depending therefrom are patentable for the above reasons and for the additional reasons next discussed.

With respect to claims 2 and 3, the '222 patent discloses a current source having a metallic anode, and no fuel cell is disclosed therein. According to the reference, a membrane is positioned not in an electrolyte chamber, but in the gap between the current collectors of the anode and the cathode; and between the electrodes there is no membrane electrolyte. This is different from the claimed invention.

Claim 2 recites a porous matrix impregnated with an alkaline electrolyte. The membrane may be implemented with the use of any non-conductive material, in particular - it may be made of asbestos (Claim 3).

With respect to claim 5, the Xing et al article discloses a hydrogen-oxygen

fuel cell having a membrane made of polybenzimidazole, not an alcohol-air fuel cell, as defined in dependent Claim 5. Apart from that, the membrane is positioned not in a chamber containing an alkaline electrolyte, as defined in Claim 1.

With respect to claim 6, the '578 patent discloses a hydrogen-air fuel cell having a liquid alkaline electrolyte, the cathode having a four-layer structure. Dependent Claim 6, defines air alcohol-air fuel cell, and the cathode of Claim 6 has a two-layer structure.

With respect to claim 7, the '501 patent discloses a fuel cell having a membrane-electrode assembly, and the gas diffusion anode and cathode. Said fuel cell has not an electrolyte chamber, a chamber containing a liquid fuel; and the cathode, is a three-layer one.

With respect to the rejection of claims 8 and 10 in paragraph 10 of the Official Action, the references do not disclose a fuel cell provided with the anode consisting of art active layer and comprising 3 - 7% of fluoroplastic and having a membrane based on polybenzimidazole. The '389 patent discloses an electrochemical cell wherein the anode comprises an ion-exchange membrane, but said reference does not teach that the membrane is implemented based on polybenzimidazole, that its active layer comprises 3 - 7 % of fluoroplastic.

The article by Xing et al discloses a fuel cell having a polymer

electrolytic membrane made of polybenzimidazole, but this reference does not mention that the polybenzimidazole-based membrane is a constituent of the anode and the active layer comprises 3 - 7% of fluoroplastic.

I

Reference 2003/0064709 teaches an anode having a layer of all hydrogen-sorbing alloy used as the active material. A fluoroplastic is used as the binder for the active material, and a quantity of fluoroplastic is determined under the condition to avoid flooding of an hydrogen chamber.

Dependent Claim 8 recites a two-layer anode consisting of an active layer comprising 3 -7% of fluoroplastic, and a polybenzimidazole-based membrane. The active layer includes a catalyst to oxidize a liquid fuel, not an active material to obtain hydrogen.

Claim 10 recites a two-layer anode comprising a porous nickel band filled with polybenzimidazole, and an active layer comprising 2 - 7% of fluoroplastic. In the references applied against claim 10, the anode of the claimed makeup is not disclosed. According to Xing, polybenzimidazole is used as the electrolyte and is not included into the anode.

The '709 patent teaches the use of a substrate of foamed nickel, but not impregnated with polybenzimidazole, and the active layer does not comprise 2 - 7% of fluoroplastic. Thus, the cited references do not show or suggest the features of dependent Claims 8 and 10, in combination with independent Claim

1.

With respect to the rejection of claim 9, this claim recites a two-layer anode, comprising 2 - 7% of polybenzimidazole, and a membrane based oil polybenzimidazole. The '898 patent discloses a gas-diffusion electrode for a fuel cell having a polymeric electrolyte. Said electrode has a hydrophobed diffusion layer made of a mixture of a conductive material and a thermostable polymer, used as the binder. The electrode may further comprise a catalytically active layer comprising an ion-conductive polymer. The cited patent does not disclose a quantity of the polymer in the active layer. Furthermore, it should be noted that the anode recited in Claim 9 is not a gas-diffusion electrode, for it oxidizes a liquid fuel, hence the claimed anode is a completely hydrophilic one.

With respect to claim 11, this claim recites a two-layer anode to oxidize a liquid fuel, which anode comprises a porous nickel band filled polybenzimidazole, and an active layer comprising 2 - 7% of polybenzimidazole. The references do not disclose an anode to oxidize a liquid fuel of the claimed composition.

According to the article by Xing, polybenzimidazole is used as the electrolyte, and is not comprised by the anode. Reference 2002/0064709 uses a substrate of foamed nickel, but said substrate is not impregnated with polybenzimidazole, nor does the active layer comprise 2 - 7% of polybenzimidazole. All the references applied against claim 11 disclose gas-diffusion electrodes while Claim 11 recites an anode to oxidize a liquid fuel.

With respect to claim 12, this claim recites a two-layer anode to oxidize a liquid fuel, comprising an asbestos layer impregnated with polybenzimidazole, and an active layer comprising 3 - 7% of fluoroplastic and 2 - 7% of polybenzimidazole. The asbestos layer in the anode serves as the substrate, on which substrate applied is an active layer, and said layer is impregnated with polybenzimidazole, not by an alkali.

The '222 patent discloses a current source having a metallic anode, and does not disclose a fuel cell, and the porous membrane is not an anode substrate, but is a separating means that is impregnated with electrolyte and is disposed in the gap between the current collectors of the anode and cathode. Said patent does not disclose an active layer comprising 3 - 7% of fluoroplastic and 2 - 7% of polybenzimidazole.

With respect to claims 14 - 16, these claims recite a non-platinum catalyst, being silver on a carbon carrier, the content of silver being 7 - 18 wt.%; carbon black or graphite with specific surface of at least 60 - 80m²/g are used as the carbon carrier. Said patents do not disclose a cathode catalyst for an alcohol-air fuel cell, comprising silver in quantity of 18 wt.% at most on a carbon carrier, with specific surface of 60 - 80m²/g.

With respect to claims 17 - 19, these claims recite non-platinum catalysts - pyrolytic polymers of N₄-complexes on a carbon carrier, the content of said

pyropolymers being 10 - 20 wt.%, and carbon black or graphite with specific surface of at least 60 - 80 m²/g being used as the carbon carrier. Claim 17 recites not cobalt tetramethoxyphenyl porphyrin (CTP), but pyropolymers of N₄-complexes. CTP disclosed in Patent '954 (col. 3, lines 30 - 40) is a particular case of pyropolymers of N₄-complexes. The change of the size of the carbon to have a surface area of 60 - 80 m²/g instead of 1000 m²/g to achieve the contemplated technical result is not apparent, because when specific surface of a carrier diminishes, surface area of a catalyst does not increase but decreases.

With respect to claims 13, 20 - 25, claim 13 cites a nickel-ruthenium system as the anode catalyst, and claim 20 recites nickel-ruthenium catalyst, wherein the Renay nickel comprises nickel and aluminium in a ratio of 50:50. Claim 21 recites the catalyst according to claim 20, comprising a molybdenum additive, wherein ratio of nickel, aluminium and molybdenum is 40:50:10. According to claim 22, the Renay nickel of claim 20 is additionally promoted with platinum. According to claim 24, the content of platinum and ruthenium in the anode catalyst is 8 - 15 wt.%, with the content of platinum equal to 0.08 - 0.3 wt.%. Claim 25 recites the fuel cell according to claim 22, wherein platinum and ruthenium in the anode catalyst are present in the form of crystals of the platinum-ruthenium alloy having a size of 5 - 7 nm and specific surface of 45 - 60 m²/g.

Patents 5,656,389; 7,056,610 do not disclose the nickel-ruthenium anode catalyst. The reference of Gray, teaching the nickel-ruthenium catalyst, cannot

be considered to show the same, because any bibliographic data of that reference were not indicated.

Patent '777 describes a platinum-ruthenium catalyst, not a nickel-ruthenium catalyst, size of the catalyst particles being 4.2 nm (see Table), not 5.2 nm as mentioned by the Examiner.

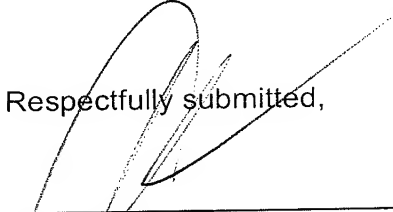
Patent '116 describes a Renay nickel catalyst that comprises an homogeneous mixture of nickel-iron-aluminium and nickel-molybdenum-aluminium. The possibility to combine the platinum-ruthenium catalyst and the nickel-molybdenum-aluminium catalyst to obtain the catalyst of claims 22 - 24 exhibiting the required characteristics could not have been obvious to a person skilled in the art. Moreover, said patents do not mention or suggest the ratio of 40:50:10 of the constituents: nickel, molybdenum, aluminum; nor do they indicate the content of platinum and ruthenium equal to 8 - 15 wt.%. and the content of platinum equal to 0.08 - 0.3 in the anode catalysts.

With respect to claim 26, the references do not disclose a three-layer anode structure to oxidize a liquid fuel, which structure includes a porous base, a layer filled with polybenzimidazole and facing the electrolyte, and an active layer comprising a catalyst and polybenzimidazole, and facing the anode chamber containing a liquid fuel.

Patent '389 discloses two-layer (not three-layer as in Claim 26)
gas-diffusion electrodes that are not suitable to operate with a liquid fuel.

In view of the above, Applicant respectfully submits that the prior
rejections and all other rejections of record have been overcome and that the
application is now in allowable form. An early notice of allowance is earnestly
solicited and is believed to be fully warranted.

Respectfully submitted,



CLIFFORD J. MASS
LADAS & PARRY LLP
26 WEST 61ST STREET
NEW YORK, NEW YORK 10023
REG. NO.30,086(212)708-1890